

# Multi-dataset collection research scenario – Air France Flight 447 Case Study

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# Air France Flight 447 Accident

- Date: 1 June 2009
- Status: Under investigation
- Site: (3.5 N, 30.5 W) Atlantic Ocean
- Fatalities: 228 (all)
- Aircraft type: Airbus A330-200



# Weather Related Investigation

- Thunderstorms in a mesoscale convective system (MCS)
- Lighting (unlikely, no damage report since 1968)
- Updrafts/turbulence
- **Rime icing** (pitot tube/probe)



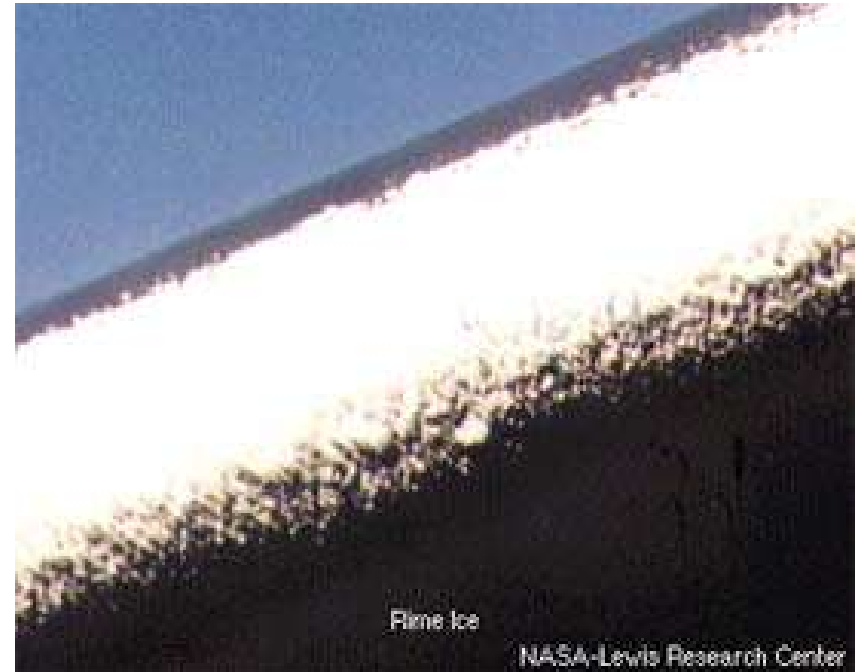
# A Possible Scenario

- Aircraft hits severe turbulence
- Auto control to reduce speed
- Malfunction of all pitot probes due to icing, causing auto control failure
- Atmospheric condition favored icing

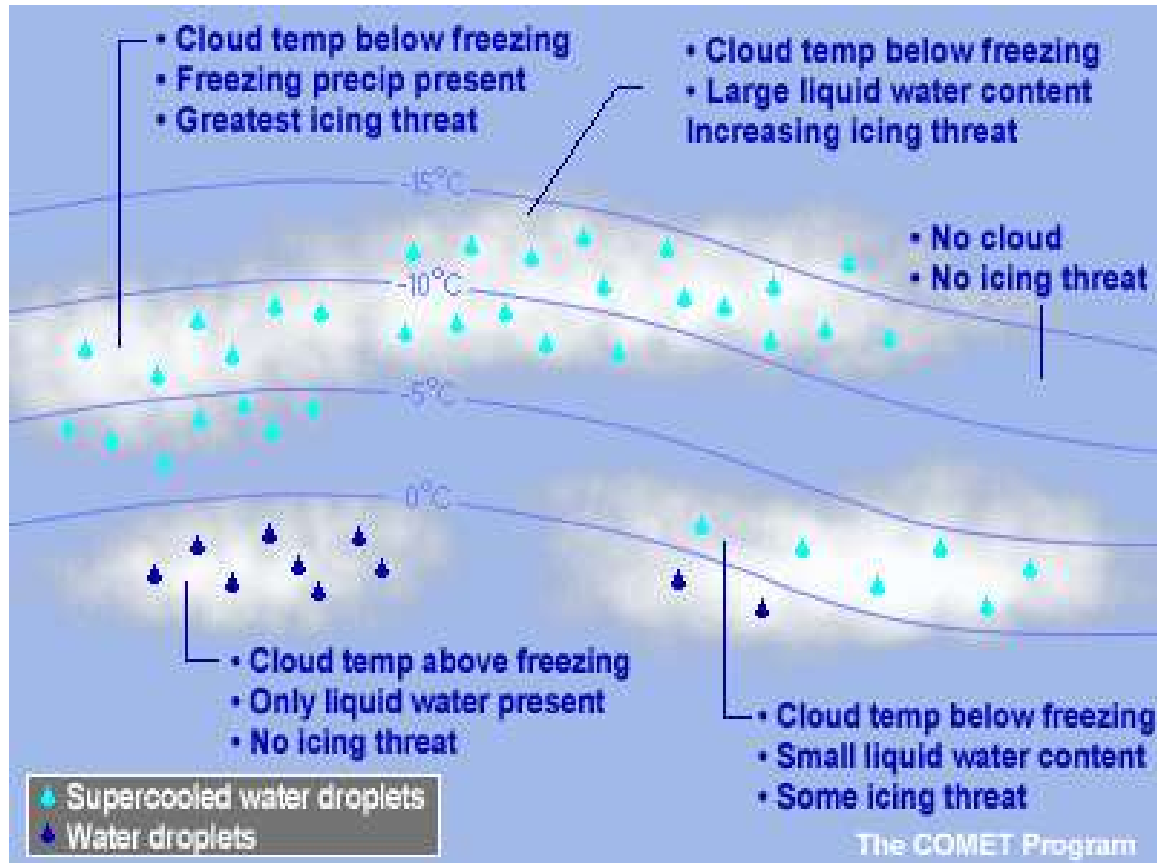


# Rime Icing

Rime icing forms when super-cooled water droplets strike an object at temperatures below freezing



# Some Basics about Icing



# What are we looking for?

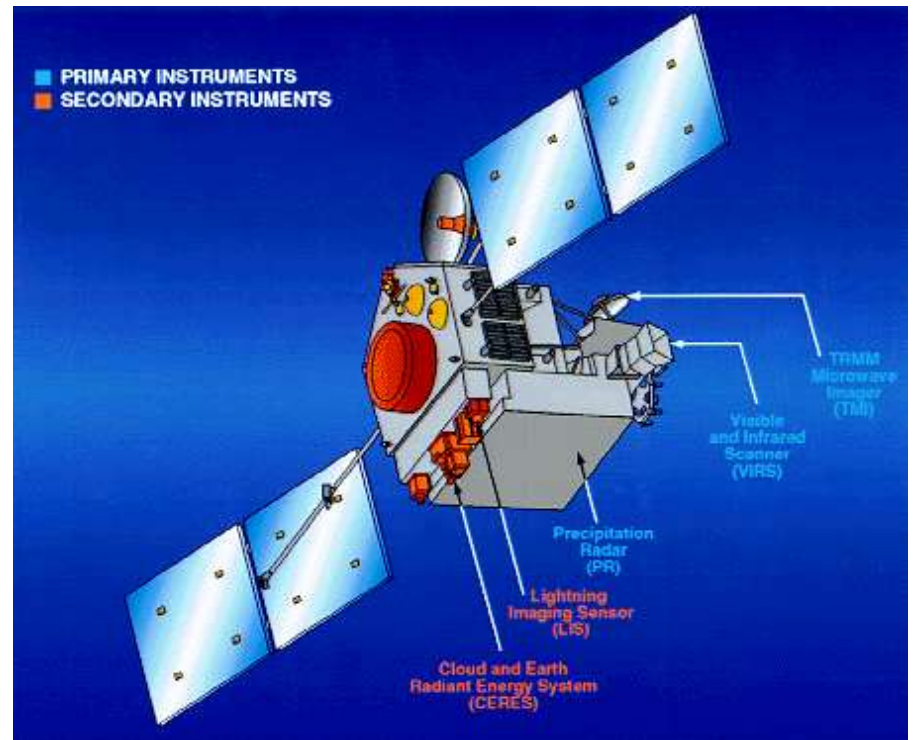
- Weather (thunderstorms?)
- Turbulence
- Icing condition
- Air temperature at 11 Km
- Cloud top temperature/cloud height (severity of convection)
- Liquid water content (LWC)

# Datasets

- Geostationary merged IR (thunderstorm, MCS development, cloud top temperatures)
- TRMM (hydrometeor profiles, cloud water, cloud ice, precipitation water, precipitation ice)
- CloudSat (hydrometeor profiles, melting layer, cloud height, etc.)
- AIRS (temperature profile, cloud top temperature)
- QuikSCAT (ITCZ, low-level convergence)
- TRMM TMI SST (MCS development)



## Satellite Observation



Geostationary IR: every 30 minutes

**TRMM: 2:30 GMT** PR malfunction

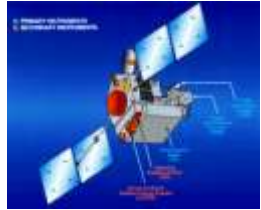


CloudSat and AIRS:  
~4:00 GMT

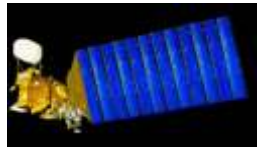
# In order to address a problem with multiple datasets:



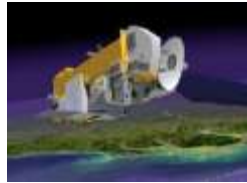
Cloudsat



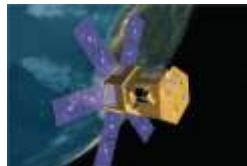
TRMM



AIRS



AURA



SORCE

8/30/2010



Information System



*Each product needs to go through these processes **differently** before analysis*







# Traditional Way vs. CEWIS in Dataset Evaluation for a New User

- Obtain data from a FTP site
- Read data manuals
- Learn software if available
- If not available, write your own software
- Write visualization software
- Basic analysis and visualization (no software and data download needed)



## A-Train Along CloudSat Track Instance

CloudSat, MLS, CALIPSO lidar, and coregistered MODIS/Aqua, AIRS, AMSR-E, OMI, POLDER/PARASOL, ECMWF, and MERRA data.

Home | Result #1  x | Result #2  x | Result #3  x | Result #4  x | Result #5  x | Results #6  x | Remove All

### Execution Status

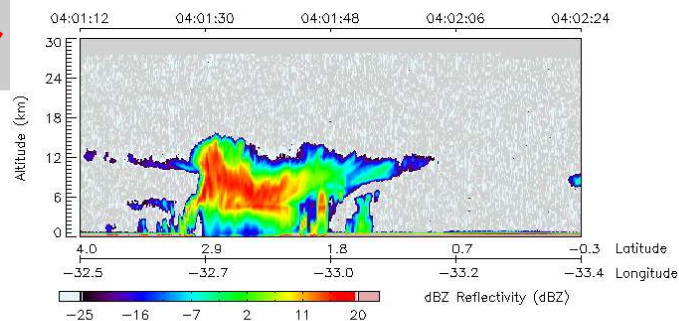
StepNumber	Operation	Status	StartTime	CompletionTime
1	Data Fetching	COMPLETE	Sun Jun 13 13:18:22 GMT 2010	Sun Jun 13 13:18:49 GMT 2010
2	Altitude to Pressure Conversion	COMPLETE	Sun Jun 13 13:18:49 GMT 2010	Sun Jun 13 13:18:50 GMT 2010
3	Swath Stitcher	COMPLETE	Sun Jun 13 13:18:50 GMT 2010	Sun Jun 13 13:18:58 GMT 2010
4	Across-Track Swath Subsetter	COMPLETE	Sun Jun 13 13:18:58 GMT 2010	Sun Jun 13 13:18:59 GMT 2010
5	Along-Track Swath Subsetter	COMPLETE	Sun Jun 13 13:19:00 GMT 2010	Sun Jun 13 13:19:03 GMT 2010
6	Feature Profiling Service	COMPLETE	Sun Jun 13 13:19:04 GMT 2010	Sun Jun 13 13:19:05 GMT 2010
7	HDF Scaling Service	COMPLETE	Sun Jun 13 13:19:05 GMT 2010	Sun Jun 13 13:19:07 GMT 2010
8	Swath Strip Rendering Service	COMPLETE	Sun Jun 13 13:19:07 GMT 2010	Sun Jun 13 13:19:09 GMT 2010
9	Swath Center Pixel Extractor	COMPLETE	Sun Jun 13 13:19:10 GMT 2010	Sun Jun 13 13:19:11 GMT 2010
10	HDF Scaling Service	COMPLETE	Sun Jun 13 13:19:12 GMT 2010	Sun Jun 13 13:19:14 GMT 2010
11	Curtain Plot Renderer	Active	Sun Jun 13 13:19:14 GMT 2010	



Responsible NASA Official: [Steven.J.Kempler@nasa.gov](mailto:Steven.J.Kempler@nasa.gov)  
Web Curator: [M.Hedge@web-contact-disc@listserv.gsfc.nasa.gov](mailto:M.Hedge@web-contact-disc@listserv.gsfc.nasa.gov)

[+ Privacy Policy and Important Notices](#)

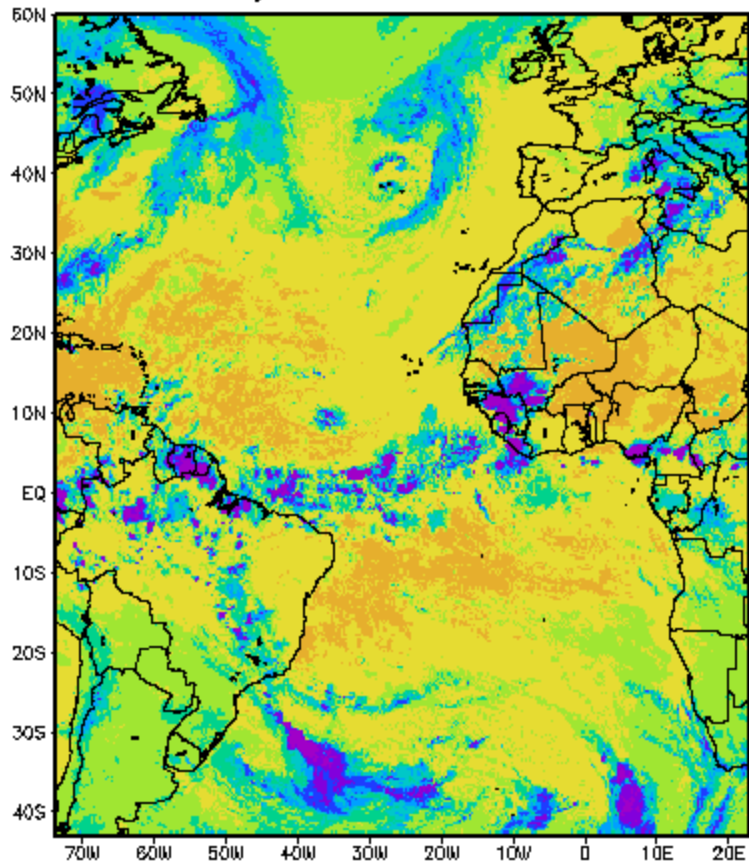
Reflectivity dBZ (CloudSat)  
01-Jun-2009 04:01:12 - 04:02:24 GMT



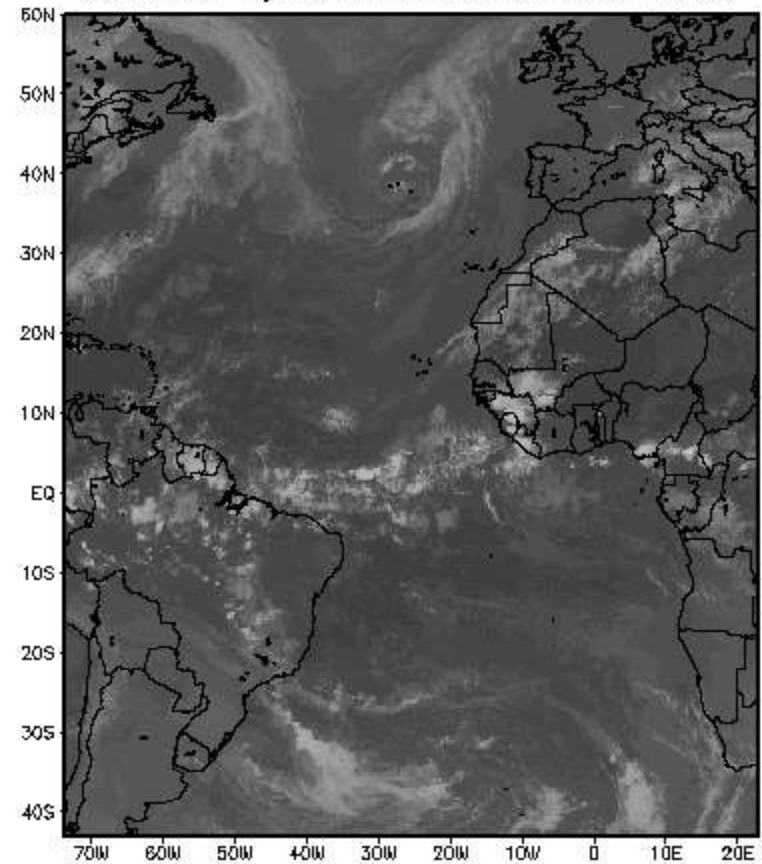
The Air France Flight 447  
here is a problem that was  
examined utilizing an energy  
and water cycle information  
system prototype

## Satellite Observation of Large-scale Environment on 1 June, 2009

Global Merged IR (00min00Z01JUN2009)  
Created by NASA Goddard GES DISC

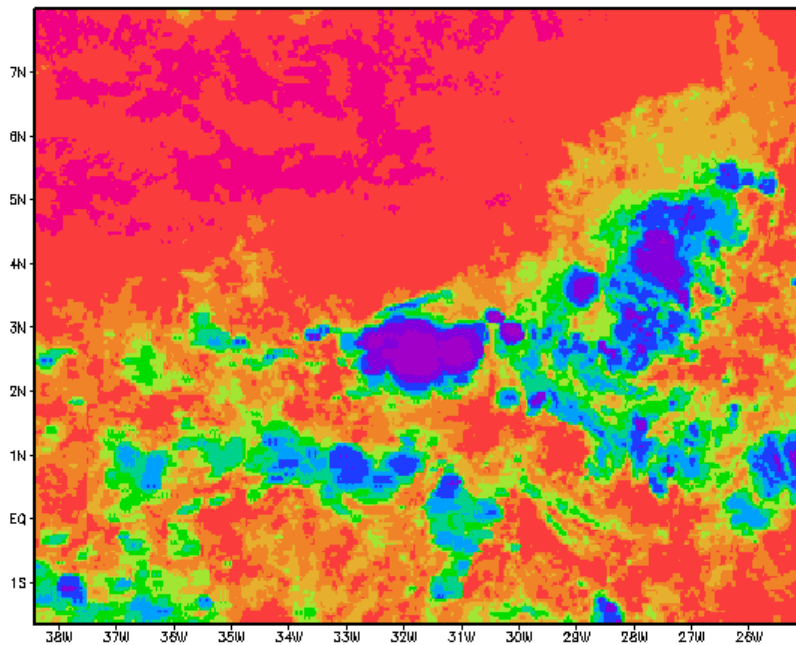


Global Merged IR (00min00Z01JUN2009)  
Created by NASA Goddard GES DISC

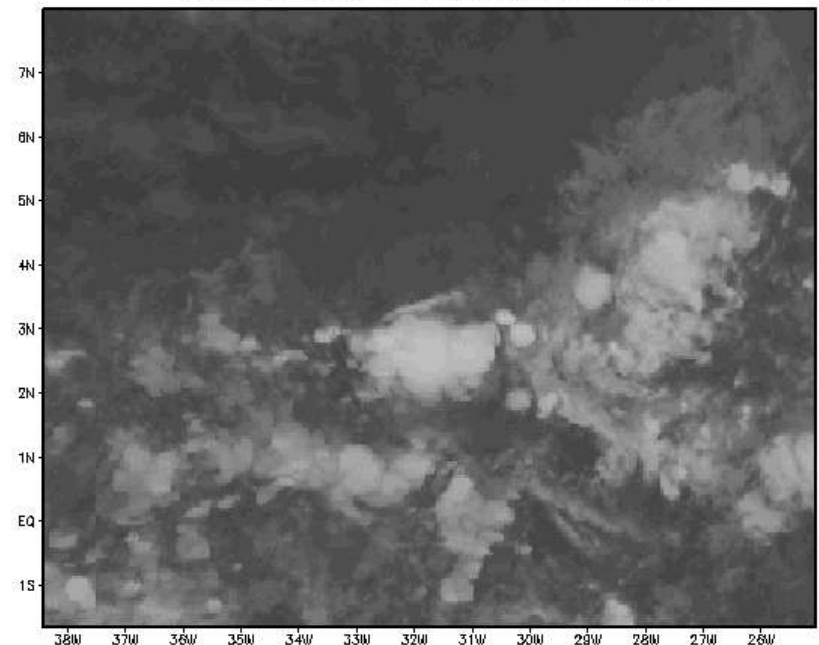


# Satellite Observation of Mesoscale Convective System Development on 1 June, 2009

Global Merged IR (00min23Z31MAY2009)  
Created by NASA Goddard GES DISC



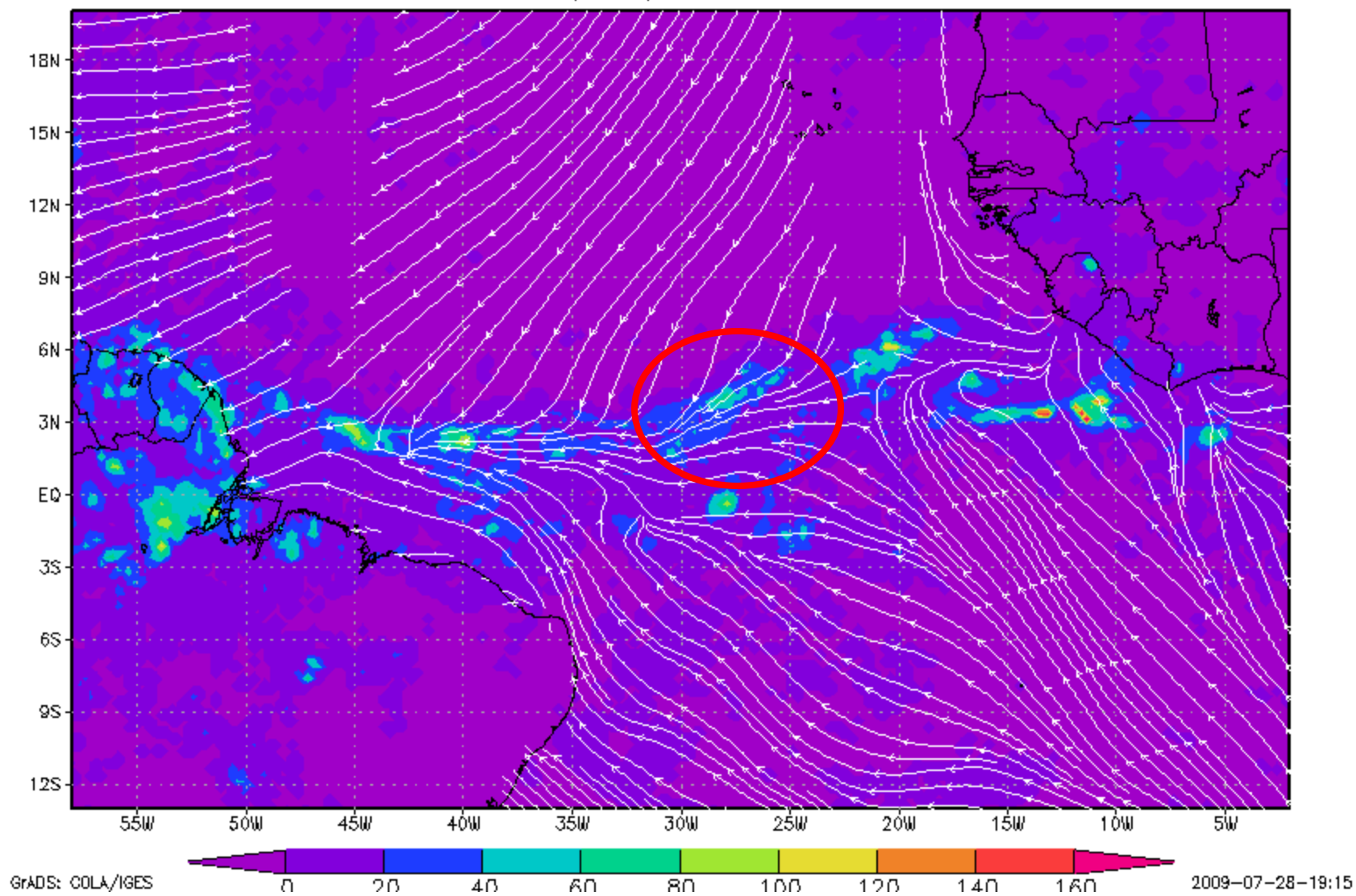
Global Merged IR (00min23Z31MAY2009)  
Created by NASA Goddard GES DISC



# MCS Development in ITCZ

(31 May 2009)

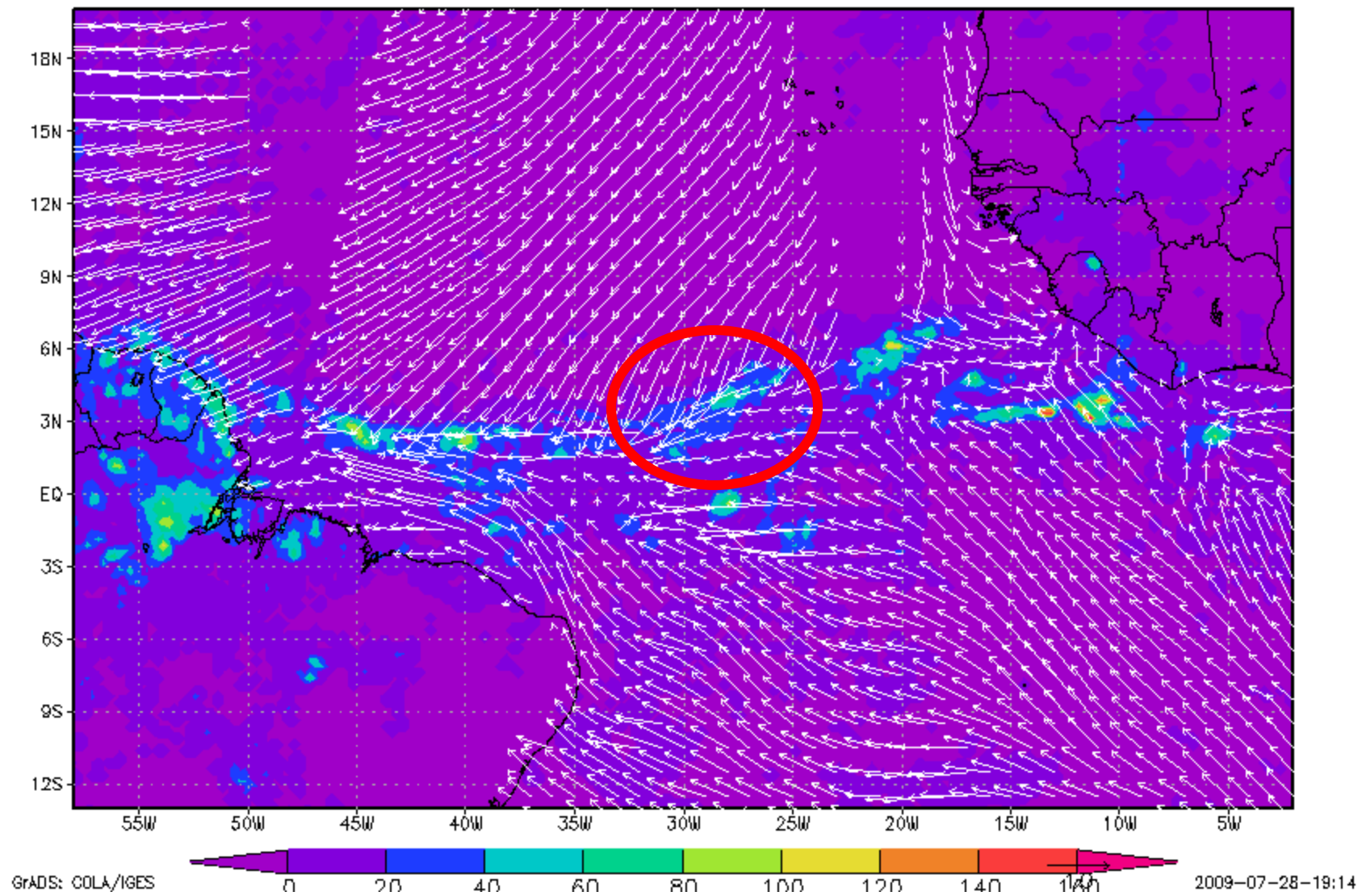
Shaded—3B42(mm) Streamline—QuikSCAT



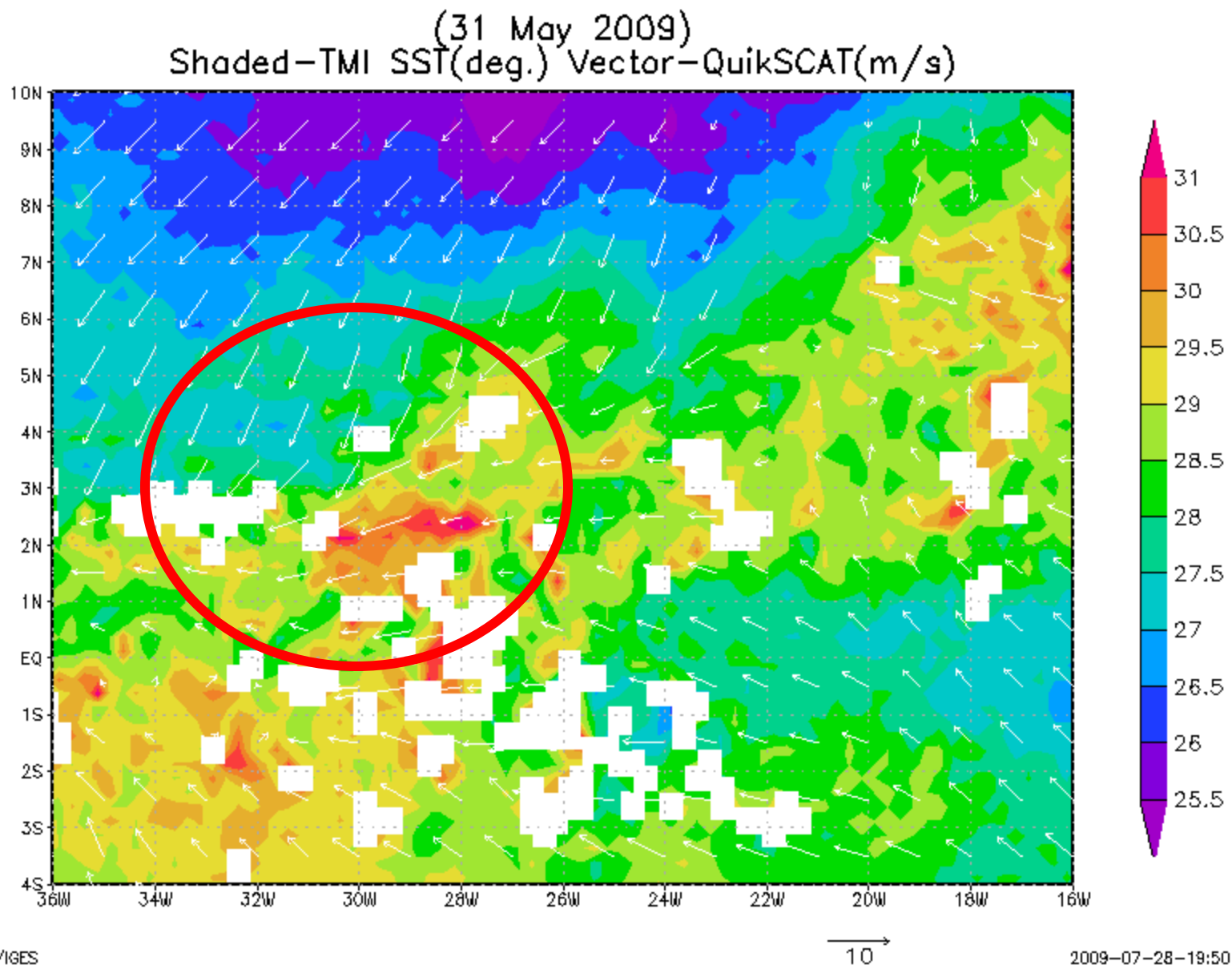


# Strong Wind Horizontal Sheer Favors Convection Development

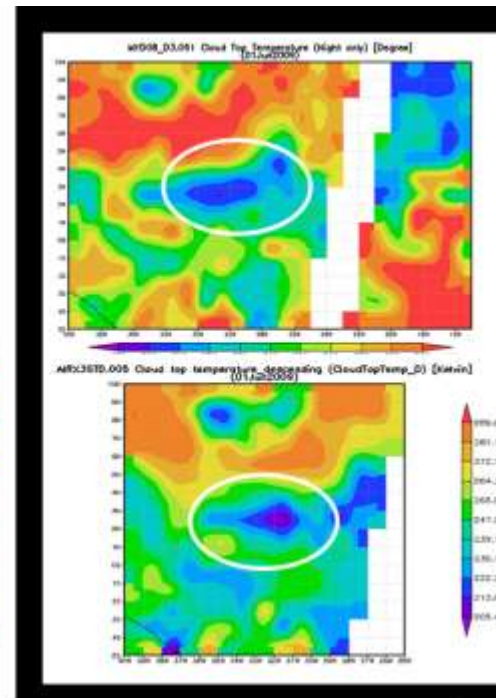
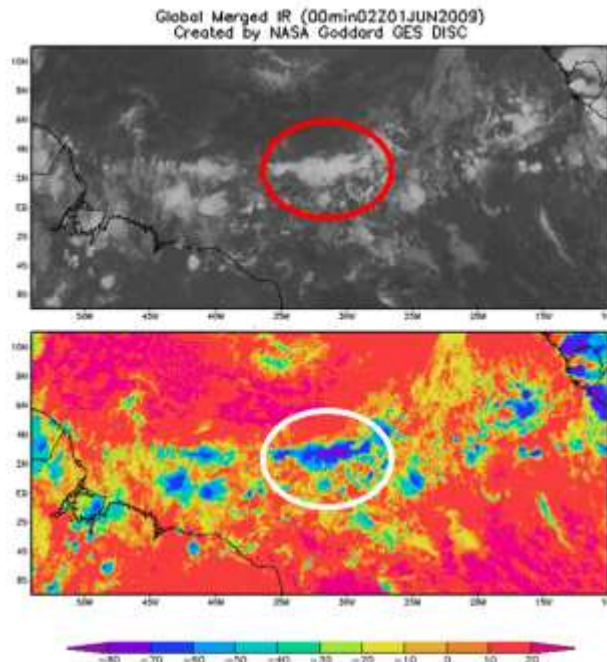
(31 May 2009)  
Shaded—3B42(mm) Vector—QuikSCAT(m/s)



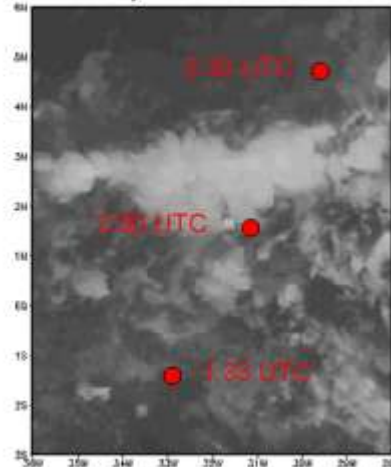
## Warmer SST Favors Convection Development



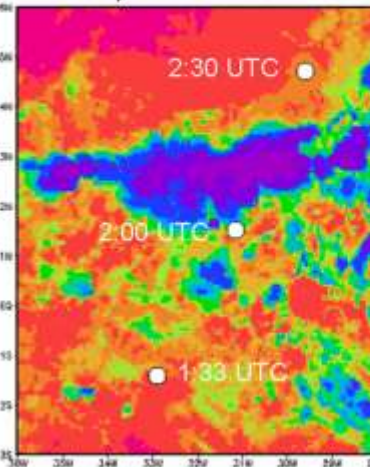
# Air France Flight 447 flew through the MCS



Global Merged IR (00min02Z01JUN2009)  
Created by NASA Goddard GES DISC



Global Merged IR (00min02Z01JUN2009)  
Created by NASA Goddard GES DISC



\*\*\*\*\* Daily AIRX3STD.005 product \*\*\*\*\*

Selected Application: crossmap\_profile

Temperature profile\_descending (Temperature\_D) [Kelvin] (Temperature\_D)

Selected time period: 01Jun2009

Selected area for averaging: Lat(2.021484375, 5.361328125), Lon(-32.958984375, -29.091796875)

Selected level: 1000.0-7.0hPa

Fill value: -9999.0

altitude Temperature\_D

(hPa) [Kelvin]

1000.000 298.290

925.000 293.517

850.000 289.961

700.000 282.633

600.000 275.328

500.000 267.891

400.000 258.164

300.000 241.945

250.000 230.977

200.000 218.031

150.000 205.338

100.000 192.469

70.000 198.216

50.000 206.034

30.000 214.633

20.000 221.349

15.000 227.021

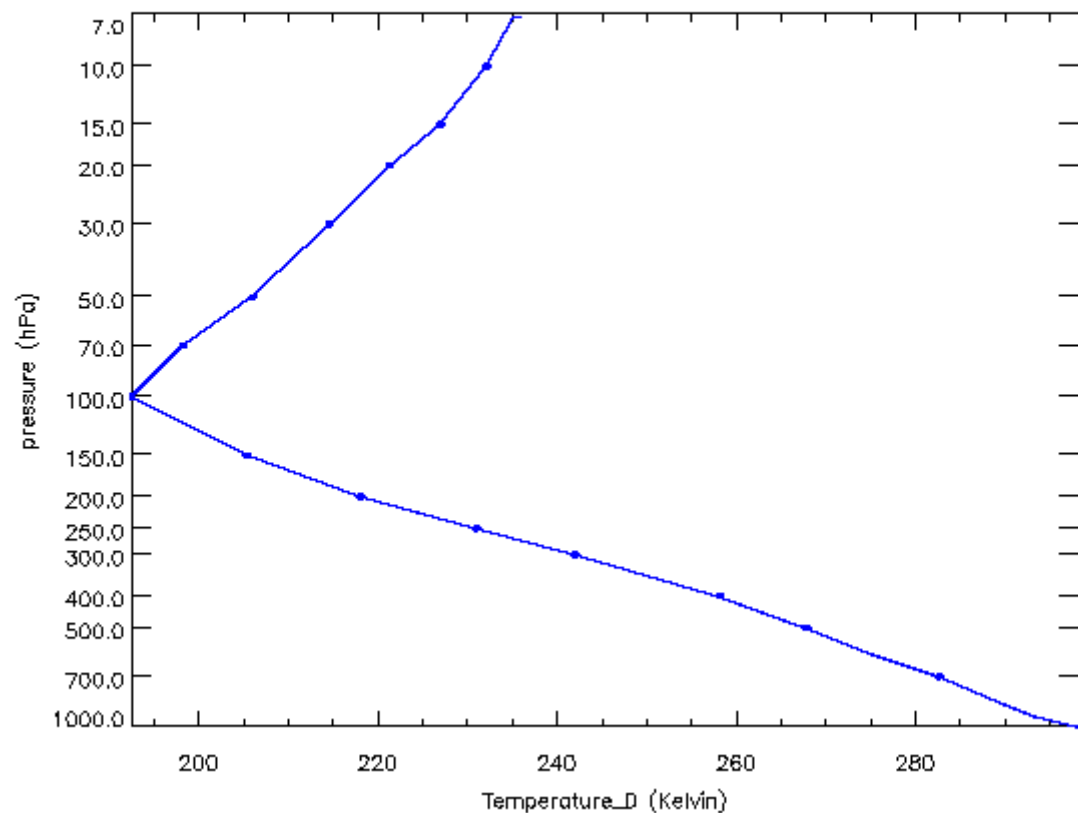
10.000 232.125

7.000 235.555

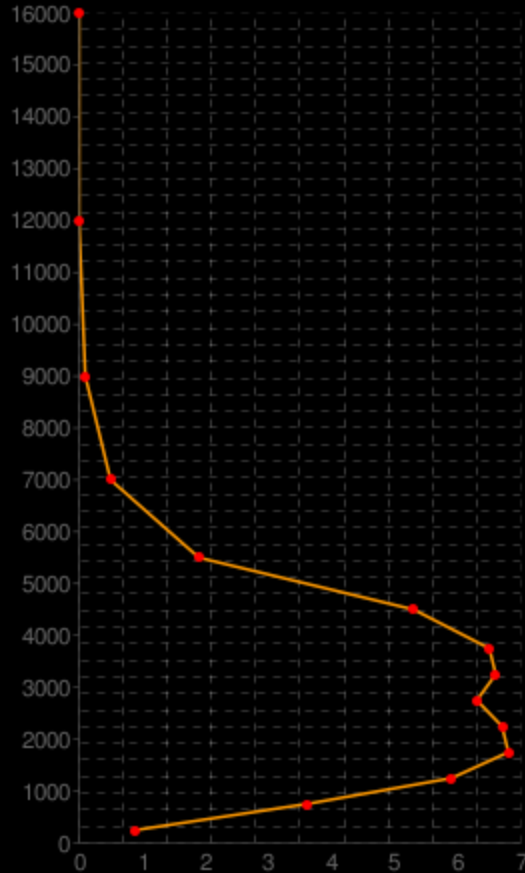
Freezing  
height

Flight  
altitude

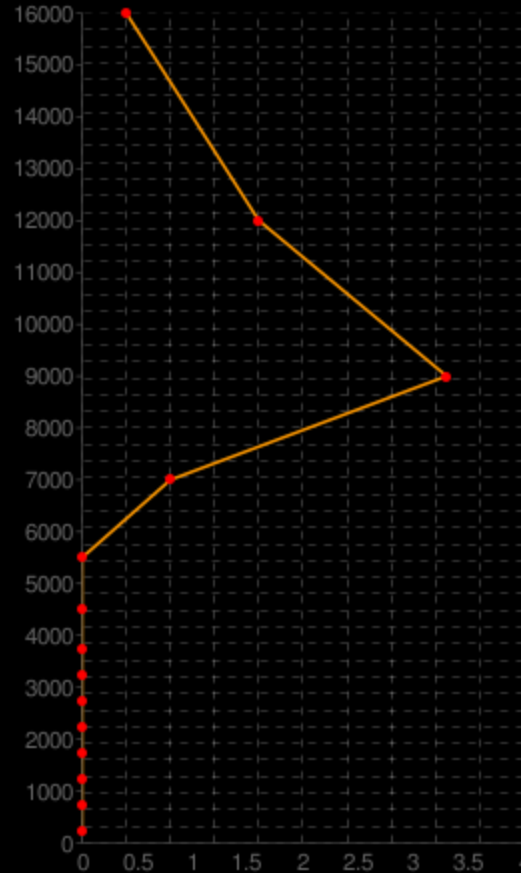
Temperature profile\_descending (Temperature\_D)  
Averaged over Longitude 33.0W-29.1W, Latitude 2.0N-5.4N and Time: 01Jun2009



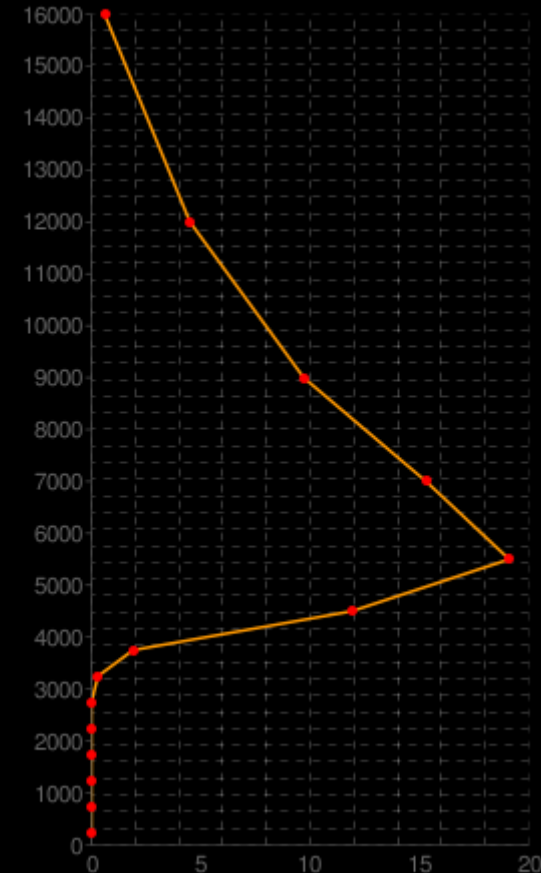
## Cloud Ice and Freezing Precipitation Presence Favor Icing



Cloud Water in g/m<sup>3</sup>  
(scaled by 100)

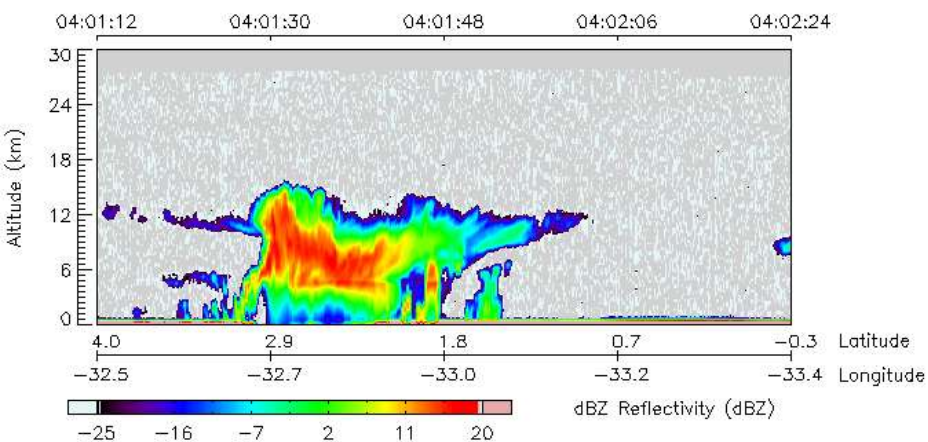


Cloud Ice in g/m<sup>3</sup>  
(scaled by 100)

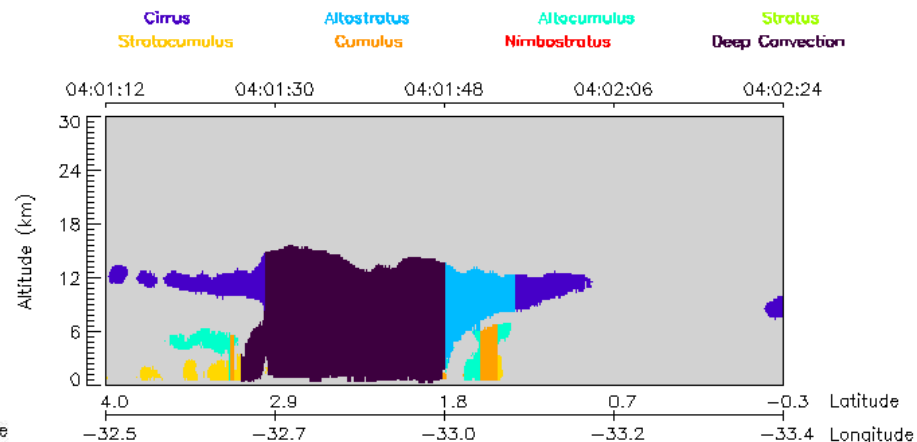


Precipitation Ice in  
g/m<sup>3</sup> (scaled by 100)

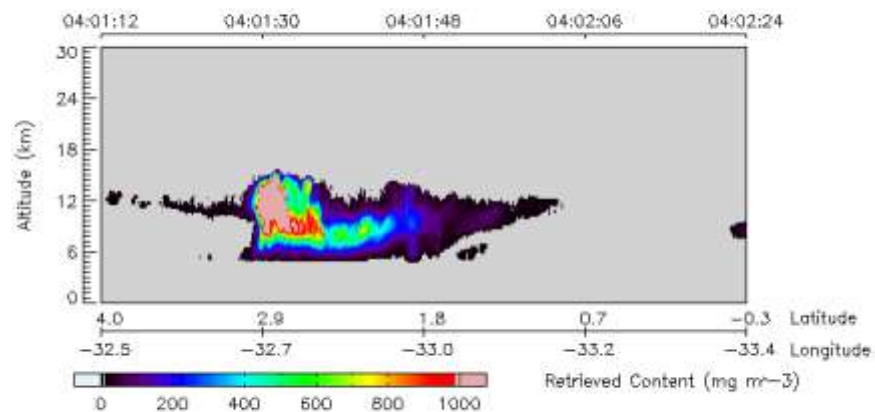
Reflectivity dBZ (CloudSat)  
01-Jun-2009 04:01:12 - 04:02:24 GMT



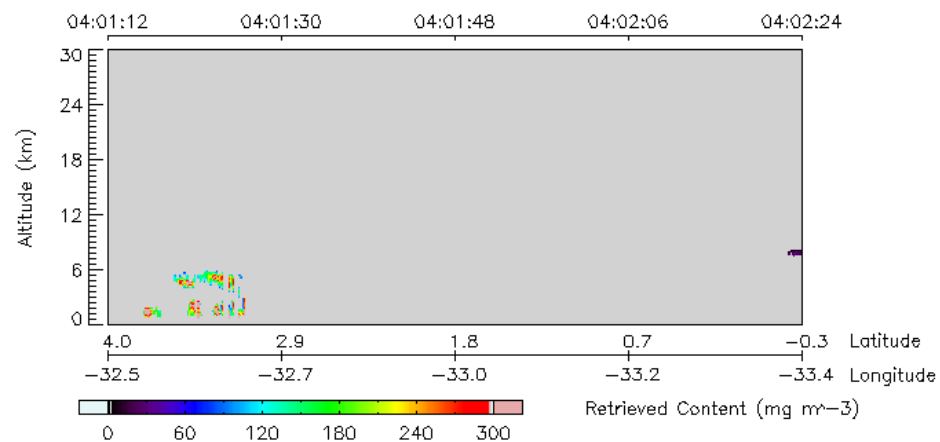
Cloud Scenario (CloudSat)  
01-Jun-2009 04:01:12 - 04:02:24 GMT



RO Ice Water Content (CloudSat)  
01-Jun-2009 04:01:12 - 04:02:24 GMT



RO Liquid Water Content (CloudSat)  
01-Jun-2009 04:01:12 - 04:02:24 GMT



# Use of Multi-datasets Indicates:

- Numerous thunderstorms in MCS
- Cloud top temperature: below -60 deg.
- Cloud ice and precipitation
- Melting layer
- All indicate strong convection, updrafts, and turbulence.
- Temperature at the flight altitude: - 40 deg.
- Presence of freezing precipitation
- Not much cloud water is found at 11 km, but consider a low bias for TRMM TMI hydrometeor profiles, Fiorino and Smith. 2006)
- Conditions favor rime icing, though additional investigation is needed regarding LWC.

# Thank You!